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REDUNDANT STRUCTURE CONTROL DEVICE FOR EXCHANGE

BACKGROUND OF THE INVENTION

(1) Field of the Invention:

The present invention relates to a redundant structure control device for an exchange, particularly to a redundant structure control device for an exchange, capable of separately dealing with trouble that has happened at any of lines and trouble that has happened at any of line interface devices which terminates the lines, in an ATM (Asynchoronous Transmission Mode) exchange having a redundant structure of lines and line interface devices.

(2) Description of the Related Art:

Conventionally, an ATM exchange has a redundant structure of lines and line interface devices wherein the ratio of lines and line interface devices for current use to spare lines and line interface devices is 1:1. When any of lines and line interface devices for current use becomes unavailable due to trouble or something, switching to a spare line or spare line interface device is performed so that the service can be continued without interruption.

Recently, in view of cost, instead of the redundant structure wherein lines and line interface devices are provided completely doubly, that is, as many spare systems as systems for current use are provided, a redundant structure has been proposed wherein a single spare system is provided to N systems for current use so that when trouble happens at any of the lines and line interface devices of the systems for current use, switching from

the system at which trouble has happened to the single spare system may be performed.

Japanese Patent Preliminary Publication Hei 9-238118 discloses switching control performed when trouble has happened. According to the disclosure, a line switching device for switching from the line and line interface device of one of N systems for current use to the line and line interface device of a single spare system is provided not as a spatial switch but as a time switch so that the line switching device may not be complicated even with an increased number of channels.

Japanese Patent Preliminary Publication Hei 11-27286 discloses another way of dealing with trouble. According to the disclosure, at least one spare device for a spare line is provided in advance, and a by-pass route is set up between the spare device and each device for current use. (When a plurality of spare lines are provided, a plurality of spare systems are connected in a row with a by-pass route.) When trouble happens at a line for current use, switching to the by-pass route set up in advance is performed so that cells may be sent out through the spare line.

In any of the conventional ATM exchanges, a line and a line interface device that holds the line are integrated. Therefore, when trouble happens at either a line or a line interface device of a system for current use, switching to the line and line interface device of the spare system is performed.

In the (N+1) redundant structure, when trouble happens at either a line or a line interface device, both the line and the line interface device of the spare system are used. Therefore,

for example, when trouble happens at a line, therefore, switching to the line and line interface device of the spare system is performed, and then trouble happens at another line interface device, the latter trouble cannot be dealt with. This is because there remains no available spare system, though the line interface device connected with the line at which trouble has happened first is in order.

Further, in the case where a plurality of lines are held in the same line interface device, if trouble happens at the line interface device, the service stops simultaneously at those plurality of lines. In the ATM, switching is performed on a VP (virtual path) or VC (virtual channel) connection basis. Measures to perform switching on a line basis are not provided. Therefore, if trouble happens at a line interface device, the effects thereof is serious.

Further, in the ATM exchange, an output route for each cell is usually determined by a line interface device located on the input side of an ATM switch. In that case, if trouble happens at a line interface device, all the paths that include that line interface device as an output route need to be changed to include a spare system instead. However, path information is usually stored in a plurality of line interface devices located on the opposite side of the ATM switch to the side on which the line interface device at which trouble has happened is located. Therefore, usually, for all the paths that include the line interface device at which trouble has happened as an output route, path information stored in the line interface devices on the input

side needs to be changed. Thus, it takes long time to change all the paths that have connections at the line interface device at which trouble has happened. For example, when 8000 connections are held in the line interface device at which trouble has happened and it takes 10 milliseconds to rewrite path information for one path, it takes 80 seconds to change all the paths. This causes a large decrease in performance of line service.

SUMMARY OF THE INVENTION

The present invention has been made in view of the above problems. An object of the present invention is to provide a redundant structure control device for an exchange capable of separately dealing with trouble that has happened at any of lines and trouble that has happened at any of line interface devices in an ATM exchange having an (N+1) redundant structure.

In order to attain the above object, a redundant structure control device for an exchange having a spare line interface device is provided. The redundant structure control device for an exchange comprises frame tag attaching means for attaching a routing header to a frame coming in from lines or line interface devices and giving tag information in the routing header; frame switching means for switching a destination of the frame to which tag information has been given, in accordance with the tag information; and routing control means for monitoring states of the line interface devices, and when trouble happens at one of the line interface devices, sending out a control signal to the frame tag attaching means so that a frame coming from a

line originally connected with the line interface device at which trouble has happened may be switched over to the spare line interface device, and arranging the frame tag attaching means so that a frame coming from the spare line interface device may flow to the line originally connected with the line interface device at which trouble has happened.

The above and other objects, features and advantages of the present invention will become apparent from the following description when taken in conjunction with the accompanying drawings which illustrate preferred embodiments of the present invention by way of example.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a block diagram showing an example of fundamental structure of a redundant structure control device for an exchange according to the present invention;

FIG. 2 is a diagram showing an example of structure of an ATM line control component having a spare line interface device;

FIG. 3 is a diagram showing a structure of an ATM concentrator;

FIG. 4 is a diagram showing an example of structure of a spare line interface device having an information replacing function;

FIG. 5 shows another example of structure for replacing information;

FIG. 6 is a diagram showing an example of structure

of an ATM line control component having a spare ATM line;

FIG. 7 is a diagram showing an example of structure comprising an ATM line control component and an ATM concentrator having a spare ATM line and a spare line interface device;

FIG. 8 shows a data form of a frame used at a frame tag attaching section and a frame switching section; and

FIG. 9 is a diagram for explaining how switching is performed when trouble has happened.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

First, with reference to the drawings, the outline of the present invention will be described.

FIG. 1 is a block diagram showing an example of fundamental structure of a redundant structure control device for an exchange according to the present invention. According to FIG. 1, in addition to a basic redundant structure comprising N sets of an ATM line 1_1~1_N and a line interface device 2_1~2_N for current use and one set of a spare ATM line 1_{N+1} and a spare line interface device 2_{N+1}, a redundant structure control device of the present invention is provided. The redundant structure control device includes (N+1) line trouble monitoring means 3, (N+1) first frame tag attaching means 4, a frame switching means 5, (N+1) second frame tag attaching means 6, a routing control means 7 and a tag changing means 8.

The line trouble monitoring means 3 are provided between the ATM lines 1_1~1_{N+1} and the first frame tag attaching means 4 to monitor line trouble. If trouble happens at any of the ATM

lines $1_1 \sim 1_{N+1}$, an associated line trouble monitoring means 3 puts out line trouble information.

The first and second frame tag attaching means 4 and 6 are each provided to add a routing header to an SDH (Synchronous Digital Hierarchy) or SONET (Synchronous Optical Network) frame coming from its associated ATM line $1_1 \sim 1_{N+1}$ or line interface device $2_1 \sim 2_{N+1}$, and give tag information in the added routing header. The tag attached by either of the associated first and second frame tag attaching means 4 and 6 is used only between those associated first and second frame tag attaching means 4 and 6.

The frame switching means 5 is provided to switch the destination of an SDH or SONET frame to which a tag has been attached by a first or second frame tag attaching means 4, 6 in accordance with the value of the tag.

The routing control means 7 is provided to identify, based on line trouble information from a line trouble monitoring means 3, a line interface device connected with a line at which trouble has happened, and send out switching instructions to first and second frame tag attaching means 4 and 6 so that a frame from the identified line interface device toward a line may be sent out to the spare ATM line 1_{N+1}. Switching from the ATM line at which trouble has happened to the spare ATM line 1_{N+1} is performed synchronized with a counterpart ATM exchange. The routing control means 7 also monitors the state of each line interface device $2_1 \sim 2_{N+1}$. When device trouble information comes from a line interface device, the routing control means 7 sends out, based on the device trouble information, a control signal to a first

frame tag attaching means 4 so that a frame coming from an ATM line originally connected with the line interface device at which trouble has happened may be switched over to a spare line interface device 2_{N+1}, and arranges a second frame tag attaching means 6 so that a frame coming from the spare line interface device 2_{N+1} may flow to the line originally connected with the line interface device at which trouble has happened. Further, when trouble happens at any of line interface devices 2_1~2_N for current use, the routing control means 7 places, based on device trouble information, path information for those cells which are flowing toward the line interface device at which trouble has happened, in the spare line interface device 2_{N+1}, and sends out tag changing instructions to the tag changing means 8.

The tag changing means 8 is provided to receive tag changing instructions from the routing control means 7 when trouble happens at a line interface device, and change a value of a tag of a cell indicating that the cell should be sent to the line interface device at which trouble has happened, to a value indicating that the cell should be sent to the spare line interface device 2_{N+1}. Thus, the cell, which has come from an ATM switch, is switched over to the spare line interface device 2_{N+1}.

With the above-described structure, when trouble happens at any of the ATM lines 1_1~1_N, a tag indicating the spare ATM line 1_{N+1} is attached to a frame that is going toward the ATM line at which trouble has happened from its associated line interface device, and based on the information in the tag, the

frame switching means 5 switches from the ATM line at which trouble has happened to the spare ATM line 1_{N+1}. Switching from the ATM line at which trouble has happened to the spare ATM line 1_{N+1} is performed synchronized with a counterpart ATM exchange. Therefore, a frame coming from the spare ATM line 1_{N+1} is given a tag indicating the line interface device originally associated with the ATM line at which trouble has happened, and switched over to that line interface device by the frame switching means 5.

Further, when trouble happens at any of the line interface devices 2_1~2_N, a tag indicating the spare line interface device 2_{N+1} is attached to a frame that is going toward the line interface device at which trouble has happened from its associated ATM line, and based on the information in the tag, the frame switching means 5 switches the frame coming from the ATM line originally associated with the line interface device at which trouble has happened, over to the spare ATM line interface device 2_{N+1}. The tag of each cell that is going from the ATM switch toward the line interface device at which trouble has happened is changed by the tag changing means 8, and the cell is switched over to the spare line interface device 2_{N+1}. Here, the spare line interface device 2_{N+1} has already been arranged to operate with path information for the line interface device at which trouble has happened.

Thus, in the ATM exchange having an (N+1) redundant structure, when trouble happens at either an ATM line for current use or a line interface device for current use, switching to either

the spare ATM line or the spare line interface device is performed. Not both the spare ATM line and the spare line interface device are occupied at a time. Therefore, when trouble next happens at the other of the ATM line for current use and the line interface device for current use, the trouble can be dealt with and the service can be continued.

Next, embodiments of the present invention will be described taking examples in which the present invention is applied to an ATM line control component and an ATM concentrator of an ATM exchange.

FIG. 2 is a diagram showing an example of structure of an ATM line control component having a spare line interface device. FIG. 2 shows a structure of an ATM line control component 11 having N lines and (N+1) line interface devices. The ATM line control component 11 includes N frame tag attaching sections 13_1~13_N that terminate N ATM lines 12_1~12_N made of, for example, optical cables, a frame switching section 14 for switching a frame, (N+1) frame tag attaching sections 15_1~15_{N+1}, (N+1) line interface devices 16_1~16_{N+1}, and a tag control section 17. The line interface devices 16_1~16_{N+1} are connected with an ATM concentrator 18. Here, all the ATM lines 12_1~12_N are for current use, N line interface devices 16_1~16_N are for current use, and one line interface device 16_{N+1} is a spare device. Normally, the frame switching section 14 connects each ATM line 12_1~12_N directly with a line interface device 16_1~16_N having the same subscript.

The frame tag attaching sections 13_1~13_N and 15_1~15_{N+1} are each provided to attach tag information to an SDH or SONET

frame coming in from an ATM line 12_1~12_N or a line interface device 16_1~16_{N+1}. The frame switching section 14 switches the destination of an SDH or SONET frame to which a tag has been attached, based on the value of that tag. The tag control section 17 monitors the state of each line interface device 16_1~16_{N+1}. When the tag control section 17 receives device trouble information, the tag control section 17 sends out switching instructions to the frame tag attaching sections 13_1~13_N and 15_1~15_{N+1} so that a tag may be attached to an SDH or SONET frame that is going toward a line interface device at which trouble has happened so that the frame may be switched over to the spare line interface device 16_{N+1}.

Here, how the ATM line control component operates when trouble has happened, for example, at the line interface device 16_N will be described. The tag control section 17 that is monitoring the state of each line interface device receives device trouble information and identifies the line interface device 16_N at which trouble has happened. Next, the tag control section 17 arranges the frame tag attaching section 13_N so that the frame tag attaching section 13_N may add a routing header to an SDH or SONET frame coming in from the ATM line 12_N and give tag information indicating the spare line interface device 16_{N+1} in the added routing header. Based on this arrangement, the frame switching section 14 switches the frame from the line interface device 16_N for current use to the spare line interface device 16_{N+1}.

The tag control section 17 also arranges the frame tag attaching section 15_N so that the flame tag attaching section 15_N may attach tag information indicating the ATM line 12_N to

a frame coming from the spare line interface device 16_{N+1}. Thus, when trouble has happened at one of the line interface devices $16_1 \sim 16_N$ for current use, the ATM line 12_N is connected with the spare line interface device 16_{N+1}, so that the service can be continued without interruption.

Thus, when trouble has happened, a line interface device to which an SDH frame should go can be chosen only by changing a tag of the SDH frame. On the other hand, a frame coming from the spare line interface device can be made to flow to a line appointed for that frame.

When trouble has happened at any of the line interface devices $16_1 \sim 16_N$, cells that are to come from the ATM concentrator 18 to the line interface device at which trouble has happened need to be arranged to go into the spare line interface device 16_{N+1}. How such cells are made to flow to the spare system will be described below.

FIG. 3 is a diagram showing a structure of an ATM concentrator. In the ATM concentrator 18, a tag changing section 19 is provided. The ATM concentrator 18 is between an ATM switch 20 and line interface devices, and has a function of checking tag information given in each cell that is coming from the switch toward a line interface device, and delivering each cell to its appointed line interface device. In accordance with instructions from the tag control section 17, the tag changing section 19 changes a tag of a cell coming from the ATM switch 20, if the tag has a particular value, to another particular value so that the cell may be routed not to an originally appointed line interface device

but to the spare line interface device.

Here, when trouble happens at a certain line interface device, a tag of a cell that is to go to the line interface device at which trouble has happened is changed to a value indicating the spare line interface device 16_{N+1}. For example, if a physical number "1" is assigned to the line interface device 16_1 and a physical number "N+1" is assigned to the spare line interface device 16_{N+1}, cells having a tag of a value "1" each goes into the line interface device 16_1. If trouble happens at the line interface device 16_1, the tag changing section 19 changes a tag of a cell that has come into the ATM concentrator to a value "N+1", if the cell has a tag of a value "1". Thus, among cells that are flowing from the ATM switch 20 toward the ATM lines, cells that are to flow into the line interface device 16_1 are arranged to flow into the spare line interface device 16_{N+1}.

Thus, the destination of cells that are flowing toward the line corresponding section can be switched by sending tag changing instructions to the ATM concentrator that holds the line interface device at which trouble has happened, only once, instead of changing paths for those cells with devices located on the opposite side of the ATM switch.

As described above, a frame or a cell coming from an ATM line or the ATM concentrator 18 is switched from a line interface device 16_1~16_N for current use to the spare line interface device 16_{N+1}, only by attaching or changing tag information. Therefore, other information such as path data remains unchanged. Next, the case where such information is replaced will be described.

FIG. 4 is a diagram showing an example of structure of a spare line interface device having an information replacing function. According to this example, a spare line interface device 16_{N+1} has a structure different from the structure of the line interface device 16_1~16_N for current use. Specifically, the spare line interface device 16_{N+1} has an information replacing section 21, path data storing memory 22 and an information replacing control section 23 for controlling the sections 21 and 22. The information replacing control section 23 is connected with a tag control section 17 and a call processor 24.

In the information replacing section 21, a preset value of cell flow for use in a UPC (Usage Parameter Control) for monitoring the amount of cells flowing in, and a header replacing operation for replacing information placed in a header of a cell on a connection basis are registered. When the spare line interface device 16_{N+1} is not in use, the information replacing section 21 is in an initialized state. The path data storing memory 22 holds UPC data for the line interface devices 16_1~16_N for current use and header replacing data, in advance.

The call processor 24 puts out path setting-up/removing orders and makes control so that the data stored in the path data storing memory 22 may always conform to data for the line interface devices 16_1~16_N for current use.

In normal operation, when the call processor 24 puts out path setting-up orders for an SVC (switched virtual connection), a PCV (permanent virtual connection) or the like, a path is set up, for example, at the line interface device 16_1.

At the same time, the call processor 24 delivers path data about the set-up path to the spare line interface device 16_{N+1}. The information replacing control section 23 places the delivered path data in an area for data for the line interface device 16_1 in the path data storing memory 22. Thus, the path data for the line interface devices 16_1~16_N for current use is stored in the path data storing memory 22 in the spare line interface device 16_{N+1}.

Here, for example, trouble happens at the line interface device 16_1. The tag control section 17 that is monitoring the state of each line interface device detects the line interface device at which trouble has happened, and informs the information replacing control section 23. The information replacing control section 23 reads the data for the line interface device 16_1 at which trouble has happened from the path data storing memory 22 and places it in the information replacing section 21. This means that the information in the information replacing section 21 is, at this time, replaced by the information for the line interface device 16_1 at which trouble has happened.

Thus, the path data in the spare line interface device can be replaced by the path data for the line interface device at which trouble has happened, quickly.

FIG. 5 shows another example of structure for replacing information. In this example, a call processor 24a has part or all of the functions of the information replacing section 21, path data storing memory 22 and information replacing control section 23 of the example shown in FIG. 4.

The call processor 24a holds all the path data about connections of the line interface devices 16_1~16_N for current use. Therefore, when trouble happens at any of the line interface devices 16_1~16_N for current use, the call processor can send out the path data about the line interface device at which trouble has happened to the spare line interface device 16_{N+1} to make the path data in the spare line interface device 16_{N+1} conform to the path data for the line interface device at which trouble has happened. Thus, the spare line interface device 16_{N+1} can obtain the required path data quickly.

Unlike the structure of FIG. 4, the structure of FIG. 5 does not need a spare line interface device 16_{N+1} having a special structure, therefore, does not cost much. Further, the structure of FIG. 5 does not need to have a path data storing memory whose size is in proportion to the number of line interface devices. Thus, the structure of FIG. 5 is advantageous, physically as well as in view of cost.

Next, a redundant structure control device for a structure in which line interface devices are only those for current use but a spare ATM line is provided will be described.

FIG. 6 is a diagram showing an example of structure of an ATM line control component having a spare ATM line. FIG. 6 shows a structure of an ATM line control component 11 having (N+1) lines and N line interface devices. The ATM line control component 11 includes a frame tag attaching section 13_{N+1} that terminates a spare ATM line 12_{N+1}. Each ATM line 12_1~12_{N+1} is provided with a line trouble monitoring section 25_1~25_{N+1} for

monitoring trouble happening at a line.

When any of the line trouble monitoring sections 25_1~25_N detects trouble happening at a line, trouble information about that trouble is delivered to the tag control section 17. For example, when trouble happens at the ATM line 12_N, the tag control section 17 sends out switching instructions to the frame tag attaching section 13_{N+1} so that a frame coming from the ATM line 12_{N+1} may be sent to the line interface device 16_N.

Further, the tag control section 17 sends out switching instructions to the frame tag attaching section 15_N so that a frame coming from the line interface device 16_N may flow to the ATM line 12_{N+1}.

FIG. 7 is a diagram showing an example of structure comprising an ATM line control component and an ATM concentrator having a spare ATM line and a spare line interface device. The structure of this example is like the structures of FIGS. 2, 3 and 6 combined together. Therefore, elements corresponding to those shown in FIGS. 2, 3 and 6 will be denoted by the same reference numbers and the detailed explanation thereof will be omitted.

With this structure, the tag control section 17 conducts, when trouble happens at any of the ATM lines 12_1~12_N, switching to the ATM line 12_{N+1}, and when trouble happens at any of the line interface devices 16_1~16_N, switching to the line interface device 16_{N+1}.

Therefore, when trouble happens at any line or any line interface device, switching is not performed to both the spare line and the spare line interface device at a time. Therefore,

when trouble happens at both a line and a line interface device, doubly, switching to the spare line and switching to the spare line interface device are performed separately, so that the line service can be continued without interruption.

FIG. 8 shows a data form of a frame used at a frame tag attaching section and a frame switching section. An SDH/SONET frame 30 flowing though an ATM line consists of a section overhead (SOH) 31, a path overhead (POH) 32 and a payload section 33. The payload section 33 contains a plurality of cells.

In the SDH/SONET frame 30, there is no room to put in tag information used at the frame switching section 14. Therefore, a tag given by the frame tag attaching sections 13_1~13_{N+1} and 15_1~15_{N+1} is additionally attached at the head of the SDH/SONET frame 30. The tag 34 consists of bits enough to represent line 1 to line (N+1), that is, all the lines for current use and the spare line.

Next, how the ATM line control component 11 and the ATM concentrator 18 operate will be described taking an example in which trouble happens doubly and switching to the spare system is performed.

FIG. 9 is a diagram for explaining how switching is performed when trouble has happened. Here, an example in which trouble happens first at an (i)th ATM line 12_i, and then happens at a (j)th line interface device 16_j will be taken.

First, when a line trouble monitoring section 25_i puts out line trouble information, a tag control section 17 sends out switching instructions to frame tag attaching sections 13_{N+1} and

15_i. Specifically, the tag control section 17 instructs the frame tag attaching section 13_{N+1} to attach a tag "i" to a frame coming in from an ATM line 12_{N+1}, and instructs the frame tag attaching section 15_i to attach a tag "N+1" to a frame coming in from a line interface device 16_i. With this, a frame switching section 14 switches a frame coming in from the ATM line 12_{N+1} over to the line interface device 16_i, and switches a frame coming in from the line interface device 16_i over to the ATM line 12_{N+1}, as indicated by solid-line arrows. At this stage, the line interface device 16_i operates normally. Therefore, trouble treatment ends.

Next, when a line interface device 16_j puts out device trouble information, the tag control section 17 sends out tag changing instructions to a tag changing section 19 so that the tag changing section 19 may change a tag "j" of a cell to "N+1". The tag control section 17 also sends out path-data placing instructions to a line interface device 16_{N+1} so that path data for the line interface device 16_j may be read from a path data storing memory and placed in an information replacing section. The tag control section 17 further instructs a frame tag attaching section 15_{N+1} to attach a tag "j" to a frame coming in from the line interface device 16_{N+1}, and instructs a frame tag attaching section 13_j to attach a tag "N+1" to a frame coming in from an ATM line 12_j.

Thus, a frame coming in from the ATM line 12_j is switched by the frame switching section 14 over to the frame tag attaching section 15_{N+1} and goes into the line interface device 16_{N+1}. On the other hand, a tag of a cell coming from an ATM switch 20 toward

a line interface device 16_j is changed by the tag changing section 19, so that the cell goes into the line interface device 16_{N+1}. In the line interface device 16_{N+1}, path data for the line interface device 16_j has been already placed. Therefore, the line interface device 16_{N+1} is already prepared to substitute for the line interface device 16_j. Thus, the line interface device 16_{N+1} operates in the same way as the line interface device 16_j. Next, a frame coming from the line interface device 16_{N+1} and through the frame tag attaching section 15_{N+1} is switched by the frame switching section 14 over to the frame tag attaching section 15_j and goes to the ATM line 12_j. Thus, even when trouble happens doubly, the service can be continued.

As described above, in the present invention, a frame switching section is provided between lines and line interface devices, and before a frame comes into the frame switching section, a tag indicating the destination of the frame is attached to the frame. Switching from a system for current use to a spare system is performed on an SDH frame basis. Therefore, necessary switching can be performed simply with simple hardware. Further, switching to a spare line and switching to a spare line interface device can be performed separately. Therefore, if trouble happens doubly, the service can be continued without interruption.

The foregoing is considered as illustrative only of the principles of the present invention. Further, since numerous modifications and changes will readily occur to those skilled in the art, it is not desired to limit the invention to the exact construction and applications shown and described, and

accordingly, all suitable modifications and equivalents may be regarded as falling within the scope of the invention in the appended claims and their equivalents.